1. Introduction
Seafarers are increasingly expected to take on heavier workloads with less crew support, and to work longer hours with less time off – on board or on shore – to recuperate.

The unique profession of seafaring involves rest and sleep in a 24 hours/day work environment that usually involves time-zone crossings, noise, heat, cold and motion. Sleep under such conditions is often difficult to obtain. Additionally, the demanding shift schedules, ship’s operations and voyage schedules constitute fatigue a prevalent phenomenon.

Under the international convention on Standards of Training, Certification and Watch keeping (STCW), it is acceptable for a seafarer to work up to 98 hours a week. This is far longer than the limit of 72 hours a week laid down in the International Labour Organization convention 180, and almost doubles the maximum of 48 hours per week in the European Working Time Directive.

The international studies on maritime accidents has shown that fatigue is continuing to be either the main cause or contributory factor in a considerable number of casualties at sea resulting in the loss of life and damage to the environment and property. In fact, fatigue's detrimental role toward performance at work is leading to errors being made and consequently resulting in fatalities. In light of these considerations, fatigue issue is of great importance to seafarers, the shipping industry and to the international maritime organizations.

Fatigue may be addressed at three levels, legislative level, operational level and controlling level. Whilst the legislative level is already in force through the MLC (new regulation), the aim of this project is to evaluate how the fatigue related legislations and guidelines are implemented by the Shipping Companies on the operational and controlling level.

2. Abstract
The world maritime transportation sector has grown rapidly due to, inter alia, the accelerated growth in the international trade industry. The increase in world trade activities fuels the need for maritime activities including shipping, sea-transport, sea forwarding and port operations. This creates a competitive environment with a significant impact on the seafarers and numerous factors causing fatigue.
In order to manage and reduce human fatigue in the maritime sector, international regulatory bodies have issued several legislative measures in the interest of seafarers’ adequate rest periods. The IMO has set certain rules in the STCW and SOLAS conventions, and the ILO in its turn has addressed this problem in the ILO convention 180, now incorporated into the International Maritime Labour Convention (MLC) 2006, already in force (new regulation).

Under the scope of this research is to explore if Shipping Companies have adopted measures to protect their crew from fatigue, as well as to evaluate the consequences of fatigue. A representative sample of companies and crew members onboard Vessels will be questioned. Then graphical methods and some statistical tools will be used for the purpose of analysis.

We do estimate that the above mentioned research will show that the potential for physical and mental fatigue amongst seafarers is high due primarily to their exposure to a large number of recognizable risk factors including operational, organizational, technological and environmental factors. Also, that although fatigue is considered a significant cause of accidents and may lead to severe losses for the company, strategies for managing and mitigating fatigue are not commonly applied.

3. What are the dangers of fatigue?
Safety at sea is endangered as crews are not fully alert, and take shortcuts. Crew health suffers, now and in the future, through taking poor care of physical and mental health needs. Comprehensive research on seafarer fatigue, published in 2012 (ITF), showed how the long working hours culture takes its toll on seafarers:

One in four seafarers said they had fallen asleep while on watch

Almost 50% of seafarers taking part in the study reported working weeks of 85 hours or more

Around half said their working hours had increased over the past 10 years, despite new regulations intended to combat fatigue

Almost 50% of seafarers surveyed considered their working hours presented a danger to their personal safety

Some 37% said their working hours sometimes posed a danger to the safe operations of their ship

Fatigue increases the risk of mental health problems (depression, anxiety, sleep disorders) and these not only reduce quality of life but also increase the risk of chronic disease and possibly death (May et al., 2002; Stansfeld et al., 2002). Suicide is also caused by psychopathology and there have been suggestions that the current working conditions of seafarers, especially under-manning, have increased the risk of self-harm (Tharakan, 2006).

4. What about on-board records?
Increased workloads are also leading to a new problem - false record keeping. Seafarers are bowing to the pressures of the job to falsify records of the hours they actually work. This practice undermines onboard safety and health - and makes the problem of long hours working and crew fatigue harder to address.

5. How can seafarers cope with fatigue?
The symptoms of fatigue can endanger crew safety, Vessel’s safety and the marine environment. The danger signs include:
Inability to stay awake
Clumsiness
Headaches and giddiness
Loss of appetite
Insomnia
Moodiness and needless worrying
Poor judgment of distance, speed, time and risk
Slow responses
Difficulty concentrating

6. Risk factors for fatigue and the prevalence of fatigue
The Cardiff Seafarers’ Fatigue Programme (Smith, Allen and Wadsworth, 2006) confirmed that there are a number of risk factors for fatigue, such as: tour length, sleep quality, environmental factors, job demands, hours of work, nature of shift, and port frequency/turnaround time. The likelihood of reporting impaired health as a result of fatigue increases as a function of the frequency of exposure to risk factors (e.g. 1-2 factors doubles the risk of being highly fatigued but 7 or 8 factors increases the risk 30 times). Diary data supports results from the survey.

Other studies confirm the high prevalence of fatigue at sea. For example, results from the New Zealand Maritime Report (Gander, 2005) show that:
• 25% of seafarers experienced fatigue on at least half their trips.
• 24% of seafarers saw others working fatigued on at least half their trips.

One survey described in the New Zealand report addressed fatigue among masters and mates working on the inter-island ferries, and found that:
• 61% of officers often or always experienced fatigue when on duty.
• 50% of officers considered that fatigue often or always affected the performance of others on duty.

7. Problems with existing legislation and guidance
Two pieces of research from the Cardiff research programme suggest that the legislation aimed at preventing fatigue at sea is not effective. The first examined the impact of the Working Time Directive and evaluated the IMO fatigue guidelines. With regard to the Working Time Directive, it is clear from the survey data that excessive working hours and inadequate periods of rest are still problematic onboard a range of vessels. Furthermore,
hours are likely to be under-recorded, either by management, or by individual seafarers wary of jeopardizing their employment by bringing their company under legislative scrutiny. Other research from the Cardiff programme evaluated the IMO guidelines on fatigue. It was concluded that lengthy, all-inclusive guidelines are no substitute for specific and implementable recommendations.

8. Fatigue in the shipping industry

Houtman et al. (2005) research programme report addresses measures, both on board as well as ashore, that are (potentially) effective in reducing fatigue. On the basis of the literature and the interviews, measures to manage fatigue were related to:

a. lengthening of the resting period
b. optimizing the organization of work
c. reducing administrative tasks
d. less visitors/inspectors in the harbor/better coordination of inspections
e. reducing overtime
f. proper Human Resource Management
g. education and training
h. development of a management tool for fatigue
i. proper implementation of the ISM-code
j. healthy design of the ship
k. health promotion at work
l. expanding monitoring of fatigue causes, behaviors or consequences, including near misses.

Houtman et al. (2005) found that the measures that were considered most necessary and effective in reducing fatigue were:
• Proper implementation of the ISM-Code.
• Optimizing the organization of work on board vessels.
• Lengthening of the rest period.
• Reducing administrative tasks on board vessels.

In order of priority, the following measures were suggested:
• Replacing the two-shift system with the three-shift system, with an additional crew member.
• Adding a crew member, but not an Officer in Charge (OIC), who will be able to take over some administrative tasks from the officer on watch or from the Master.
• Changing the shift system into a more flexible one, with a rest period of at least 8 hours.
• Identifying administrative tasks that can be carried out by the organization ashore using IT facilities.
• Setting up the framework for a Fatigue Management Tool/ Programme.

At the last SIRC (Seafarers International Research Centre) Symposium in 2014, reported a number of comments made by participants from various shipping companies, management companies and maritime colleges in the UK, Philippines and Singapore that illustrate some of the underlying issues associated with seafarers’ fatigue. Ten focus groups were conducted
with managers from 4 shipping companies, a group of engineers, two groups of deck officers, a group of cadets, a group of ratings and a mixed group of officers. Additional burdens on seafarers were found to include: extra paperwork, ISPS drills and longer working hours.

“In the past you could probably just get on with your job but now you have got all this extra paperwork to tell you how to do your job” (Deck officer).

Paperwork not only adds to the amount of work but interferes with other activities as shown by a comment from a captain who talked about finishing his paperwork instead of being on the bridge as his vessel approached port.

The ISPS code requires that vessels must carry out drills and have documented plans regarding security. Such requirements were often perceived as placing additional and unreasonable demands on the crew:

“14 drills it’s impossible. OK we are doing it, but by paper. We have to follow the regulations, but practically it’s not possible” (Deck officer).

The stress of long working hours is compounded by the awareness that fellow crew members are in a similar condition and may also represent a safety risk.

“I work about 14-15 hours a day, so by the start of your second week. I know I start to make mistakes because I am practically falling asleep” (Deck officer).

“I’ve seen situations onboard where as well as watching out for your own personal safety I’m watching everybody else’s as well. It’s not their fault it’s just they’ve been so overworked and they get to a stage when they’re just so tired they become a danger” (Cadet).

“I think that the majority of accidents happen due to lack of rest. I mean I know that if I have been doing some jobs I take shortcuts because I know when the jobs are finished I will get to my bed” (Deck officer).

Why do seafarers fail to report excessive working hours? A simple explanation may be fears about contract renewal.

“Even if a duty officer says I cannot do it, the company will within 24 hours say OK I will find somebody who can” (Deck Officer).

“Everyone knows that the documentation (about working hours) is fudged” (Deck officer).

In operating a vessel with the minimum levels of manning, there is no in-built contingency to allow for recovery time.
“It’s no good the guy saying well if the master knew he was tired he should get someone else in to do it; you are getting to the stage where there isn’t anyone else” (Captain).

Insufficient crewing also led to single crew members often doing jobs which ideally required two people for safe conduct.

“When I was a cadet the chief officer always made sure everybody worked in twos – but now the mate has got too much work to get done so he just lets people work everywhere” (Deck officer).

9. High potential for fatigue in seafarers
Most of published reports reviewed the evidence relating to seafarers’ fatigue. Reports from diverse sources, including structured interviews and surveys, confirm that fatigue is a major issue at sea.

10. Strong association between fatigue and accidents
It is now possible to assess perceptions of fatigue and these have been shown to be linked to both reduced safety and impaired health. These associations with objective indicators are important as some people suggest that reports of fatigue reflect characteristics of the individual rather than the impact of the nature of work.

11. Inadequate regulation
Given the undisputed risk of seafarers’ fatigue it is surprising that little improvement in the situation has occurred in recent years. There have been some attempts to prevent or manage fatigue by legislation and guidance. The problem with these approaches is that there has been little attempt to evaluate their efficacy.

12. The way forward, treat fatigue as a serious health and safety issue
Walters (2005) has argued that a large proportion of the toll of work-related death, injury and ill-health amongst seafarers arises from failure to manage health and safety effectively.

13. A more robust approach to regulation and manning
A starting point for improving the situation must be a more robust approach to regulation. It is important to ensure that potential fatigue is taken into account when setting appropriate manning levels. Manning levels need to be addressed in a realistic way that prevents economic advantage accruing to those who operate with bare minimums.

14. Enforcement of legislation, elimination of false record-keeping, and better training and guidance
Another essential requirement is to enforce existing guidelines with mandatory provisions and take serious measures to overcome the problem of false record-keeping. This must be supplemented with appropriate training and guidance regarding avoidance of fatigue and optimum working conditions. Lessons can be learned from other transport industries and it is important to seek examples of best practice and apply these in an effective way to the
maritime sector. Methods of addressing issues specific to seafaring are now well developed and a holistic approach to the issue of fatigue can lead to a culture that benefits the industry as a whole.

15. This Report
This report has attempted to examine fatigue within European Ship- Owning and Managing Company’s and make comparisons with other transport sectors. Much of the report has been concerned with identification of risk factors for fatigue, the prevalence of fatigue and the consequences of it. This process has also identified the best methods of preventing and managing fatigue and it is apparent that the principles of “best practice” have been identified and operationalised in some contexts.

16. Research Methodology
Research can be classified according to the:
- purpose of the research – the reason why it was conducted
- process of the research – the way in which the data were collected and analyzed
- logic of the research – whether the research logic moves from the general to the specific or vice versa
- outcome of the research – whether the expected outcome is the solution to a particular problem or a more general contribution to knowledge.

<table>
<thead>
<tr>
<th>Type of research</th>
<th>Basis of classification</th>
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</thead>
<tbody>
<tr>
<td>Exploratory, descriptive, analytical or predictive research</td>
<td>Purpose of the research</td>
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<tr>
<td>Quantitative or qualitative research</td>
<td>Process of the research</td>
</tr>
<tr>
<td>Applied or basic research</td>
<td>Outcome of the research</td>
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<tr>
<td>Deductive or inductive research</td>
<td>Logic of the research</td>
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The aim of this research project is to explore the perception and practices of the Shipping Company regarding fatigue of their crew by collecting qualitative data that are quantified and analyzed statistically, which will be used to provide an overview of the approach the Companies have towards effectively addressing fatigue. The research was based on the inductive model.

For this reason, a survey was performed with the aid of a questionnaire. The target sample was identified and it consisted of 80 Shipping Companies. The questionnaire consisted of 16 issues to be replied and included company’s perception of fatigue management, role of fatigue in maritime accidents, perception of accuracy of records and of value of training as well as perception of future measures.

The questionnaire used is available in the appendix I.
17. Results from the Questionnaire
The results from each question are presented below.

1. What type of vessel does your Company operate?

<table>
<thead>
<tr>
<th>Vessel Type</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Tankers</td>
<td>46%</td>
</tr>
<tr>
<td>Bulk Carriers</td>
<td>30%</td>
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<tr>
<td>Containers</td>
<td>12%</td>
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<tr>
<td>Passenger</td>
<td>9%</td>
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<tr>
<td>RO-RO</td>
<td>3%</td>
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</tbody>
</table>

2. What is the average age of fleet Vessels operated by your Company?

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>1-5 Years</td>
<td>11%</td>
</tr>
<tr>
<td>5-10 Years</td>
<td>45%</td>
</tr>
<tr>
<td>10-15 Years</td>
<td>30%</td>
</tr>
<tr>
<td>15-20 Years</td>
<td>9%</td>
</tr>
<tr>
<td>20-25 Years</td>
<td>5%</td>
</tr>
</tbody>
</table>
3. Is your Office staff and Fleet crew fully alerted about fatigue related legislations?

- Yes: 65%
- No: 35%

4. Do you think that the human fatigue should be treated as:

- Health Issue: 35%
- Safety Issue: 45%
- Nothing: 6%
- Both Health and Safety: 14%
5. Have you ever received any near miss and/or incident report related to the human fatigue?

- Yes: 68%
- No: 32%

6. If yes to q 5, which of below symptoms of fatigue reported through the above mentioned reports?

- Inability to stay awake: 48%
- Clumsiness: 7%
- Headaches: 4%
- Giddiness: 2%
- Insomnia: 22%
- Poor judgment: 11%
- Slow responses: 6%
- Difficulty concentrating: 0%
7. Do you think that the human fatigue is a major factor in maritime accidents and may result:

- Collision: 33%
- Grounding: 27%
- Pollution: 20%
- Personal injury: 14%
- Nothing from the above mentioned: 6%
8. Is human fatigue considered as a major factor in your Company’s incident/accident investigation?

- Yes: 54%
- No: 46%
9. Do you have official policies and procedures integrated in Company’s ISM code related to the management and mitigation of human fatigue onboard?

- Yes: 78%
- No: 22%
10. If yes to q 9, do you find them effective, or you consider that further development is required?

- Find them effective: 38%
- Need further developments: 62%

11. Which of below factors do you think mostly affect the human fatigue onboard?

- Voyage Length: 5%
- Contracts: 11%
- Sleep Quality: 4%
- Job Demands: 20%
- Hours of Work: 34%
- Ports of Call Frequency: 12%
- Level of Noise: 4%
- Ship Vibration: 7%
- Quality of Food: 3%
12. Do you think that seafarers are increasingly expected to take on heavier workloads with less crew support, and to work longer hours with less time off to recuperate?

- Yes: 48%
- Occasionally: 32%
- No: 20%
13. If yes or occasionally to q 12, do you think that crew’s working hours:

- Present danger to their personal safety: 25%
- Undermine onboard safety: 53%
- False record keeping of the hours worked: 22%
14. Which of the following do you consider as main reason why resting hours cannot be met?

- Inadequate Manning: 56%
- Various Surveys-Inspections: 18%
- Frequency of Operations: 15%
- Works of Maintenance: 5%
- Vessel Trading Routes: 6%

15. Which of the following measures you consider as most necessary and effective in reducing fatigue:

- Improving of sleeping berths: 35%
- Reducing of noise in the accommodation area: 18%
- Reducing of noise: 6%
- Lengthening of the rest period: 12%
- Optimizing the organization of work on board: 10%
- Proper implementation of Company SMS code: 7%
- Attending of training courses: 4%
18. Major Findings
- Almost 50% thinks that the human fatigue should be treated as a safety issue
- One in four seafarers reported they had fallen asleep while on watch
- Some 35% considers the reducing of administrative tasks onboard the most necessary and effective in reducing the fatigue
- Around half said the working hours had increased over the past 10 years, despite new regulations intended to combat fatigue
- Almost 60% of companies taking part in the study consider that the inadequate manning is the major reason why resting hours cannot be met
- Some 34% said that the working hours is the factor that mostly affects the human fatigue onboard
- The 85% believes that Vessel’s manning levels need to be addressed to more realistic way

19. Proposals
In order of priority, the following measures are suggested:
- Replacing the two-shift system (6hrs-6hrs) with the three-shift system (4hrs-4hrs), with an additional crew member.
- Adding a crew member, but NOT an Officer in Charge (OIC), who will be able to take over some administrative tasks from the Officer on watch or from the Master.
- Changing the shift system into a more flexible one, with a rest period of at least 8 hours.
- Identifying administrative tasks that can be carried out by the organization ashore using IT facilities.
- Setting up the framework for a Fatigue Management Tool/Programme.
- The human fatigue onboard is a serious safety and health issue and must be treated like all other serious safety matters by the Shipping Companies.
- Seafarers guidance and training must be improved.

20. References

Belić T, Zec D. (2006). Influence of ship technology and work organization on


